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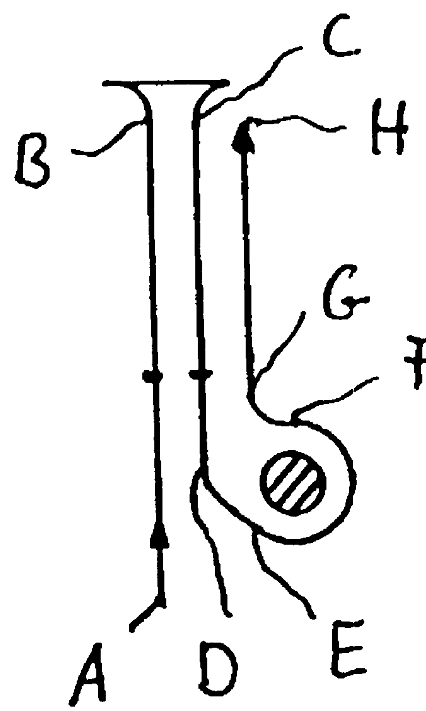
(71) Demandeur/Applicant:
GEO TEC ELECTRONICS GMBH, DE

(72) Inventeurs/Inventors:
BITTNER, GUNTHER, DE;
GLASMACHER, HANS, DE

(74) Agent: ORANGE & CHARI

(54) Titre : METHODE DE PLANIFICATION DU PARCOURS ET DES FONCTIONS D'EXECUTION D'UNE MACHINE AGRICOLE ET DISPOSITIF D'EXECUTION

(54) Title: METHOD OF PLANNING THE ROUTE AND THE OPERATIONAL FUNCTIONS OF AN AGRICULTURAL MACHINE AND A DEVICE FOR EXECUTING IT



(57) Abrégé/Abstract:
A method of planning the route of a machine and for steering the machine on this route is disclosed, in which signals are transmitted to the machine by means of a computer in accordance with the planned route stored in a storage medium, in order make it possible to control of the machine on the route, wherein the route consists, starting out from a starting point, of a plurality of route elements, of which differently defined route elements for planning the route are provided.

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Abstract

A method of planning the route of a machine and for steering the machine on this route is disclosed, in which signals are transmitted to the machine by means of a computer in accordance with the planned route stored in a storage medium, in order make it possible to control of the machine on the route, wherein the route consists, starting out from a starting point, of a plurality of route elements, of which differently defined route elements for planning the route are provided.

METHOD OF PLANNING THE ROUTE AND THE OPERATIONAL FUNCTIONS OF AN AGRICULTURAL MACHINE AND A DEVICE FOR EXECUTNG IT

Description

The invention relates to a method of planning the route of a movable machine and for optionally planning operational functions of the machine depending on the route, and for steering the machine on this route and/or for controlling the operational functions.

Such systems are known in the field of agriculture, for example, which serve for planning and controlling the route of an agricultural machine and, parallel thereto, the functions of the implements of this machine for soil tilling depending on the route.

Such a route planning system is known from EP 0 821 296 A2. In the known systems, a lattice structure is used which is laid above the surface to be tilled. The route is then determined from lattice point to lattice point in the desired manner. For steering the vehicle or the machine between lattice points, known interpolation methods can be used.

In this connection, the accuracy of planning the route and, if necessary, of planning the operational functions of the machine, such as scattering seeds, depends on the lattice structure. The finer this structure, the more precise the planning of the route and, if necessary, of the operational functions. However, the finer this structure, the higher the number of points which have to be processed by a computation unit, and the greater the demands made on

steering the machine and also on the data transfer when the machine is to be operated by remote control.

It is the object of the invention to provide a method by means of which the route of a machine can be planned highly accurately but not entailing too great expenditure, and by means of which the machine can be steered on this route.

Preferably, the system is to be suitable for planning and controlling also the operational functions of the machine.

This problem is solved by the features of claim 1. A method of planning the route of a machine and for steering the machine on this route is provided in which signals are transferred to the machine by means of a computation unit corresponding to the planned route stored in a storing unit, in order to make it possible to steer the machine on the route. The route consists, starting out from a starting point, of a plurality of route elements of which differently defined route elements for planning the route are available.

By this method, planning a route and steering the machine as well as planning and controlling the operational functions of a machine are made possible independently of a lattice, and thus in a highly accurate manner but not entailing too great expenditure. Since the route elements are exactly defined, no interpolation methods are required and the data quantities are kept low, although the route can be determined to a hundred percent. The same applies to the planning and performance of operational functions of a machine. A seed scattering machine, for example, can be controlled for performing different ways of scattering, e.g. for scattering different quantities, depending on the route and completely independent of a lattice structure.

The independence of a lattice structure has numerous further advantages. Particularly in small-sized fields which have a complicated shape or many obstacles, such as trees, brooks or the like, it is often difficult to plan a suitable route by means of a lattice structure, or the lattice structure must be made so fine that the data amount is enormous and difficult to handle. Moreover, problems arise when operational functions are to be changed between two lattice points. For example, small-sized parcels of test fields are each provided with different seeds. If the test parcels do not correspond with the parcels resulting from the lattice structure, it is not easily possible to change the seed scattering or any other ground treatment.

By using the method according to the invention, however, the route and also the operational functions of the machine can be planned in any manner by choosing suitable route elements, and even if the specifications are complicated, the suitable route and the desired operational function can be planned without much expenditure.

All sorts of route elements can be available as defined route elements. Straight route elements, curved elements or standard manoeuvres, such as turns for turning over a vehicle; in this connection, different sorts of turns can be provided. Curved elements can be subdivided into circular segments with a fixed radius and transition curves with changing, but defined radii. Of course, the lengths of the route elements can differ from each other.

The straight route elements can be defined sufficiently by their lengths alone. Curved elements with fixed radii can be defined by their radii and their route lengths or by their radii and angle portions. Transition curves are

particular curved elements fixedly joined together. Therefore, transition curves can be defined by adding the individual curved elements.

The route elements can be provided with an indication of the route direction, i.e. a starting and an end point. Thereby the steering of the machine is even more simplified, because no additional information regarding the route direction is required. In this manner, it is excluded effectively that the machine is driving on the right route, yet in the wrong direction.

Operational functions of the machine can be assigned to the route elements, in particular ground treatment functions of the machine for ground treatment depending on the route. For instance, fields can be plowed in different ways. When using the system in the field of building construction, for example, a foundation soil can be leveled by removing more or less ground depending on the route in order to obtain a plane surface.

Also machine-specific parameters can be assigned to the route elements. If the machine is to be operated by remote-control, for example, machine-specific parameters of the machine regarding drive, steering etc. have to be assigned to the route elements in order to make an automatic control of the machine possible on the planned route, for example by a computer. If operational functions of the machine are to be controlled, for example soil tilling, tilling parameters have to be connected with the route elements.

Planned routes are often used for different machines or operational functions. In tHis case, it is useful to file the routes in a route library in order to connect them with

machine parameters and/or data concerning operational functions of the machine when required.

Machine-specific parameters can be filed in a machine library which can also contain data regarding the operational functions of this machine.

In the following, the method according to the invention will be explained in more detail by means of four figures.

Figure 1 shows a section of a route planned by the method according to the invention.

Figure 2 shows a detail of a route.

Figure 3 shows the subdivision of a field into parcels in accordance with a lattice structure.

Figure 3 shows the subdivision of a field into parcels in accordance with certain requirements depending on the use of the field.

Figure 1 shows a section of a route which contains turning and driving round an obstacle 1, for example a tree. Starting out from a starting point A, a straight route portion to a point B is covered which is combined of two straight route elements. At point B, a turn is to be made in order to drive back parallel to the straight route portion. For this purpose, a "standard turn" route element is provided which is located between points B and C. It is driven from point C on a straight route portion to point D in the opposite direction. This straight route portion is also combined of two differently long, straight route elements.

Obstacle 1 is to be driven round by means of a circular segment which shows a particular radius and a particular length or angle. So as to reach the starting point E of this route element "circular segment" from point D, a so-called transition curve is necessary which does not show a constant radius, but is exactly defined and is provided as route element, as well. The shown transition curve is combined of two circular segments and exactly defined thereby, namely by the radii of the two circular segments and the angle portion across which they extend being fixed.

So as to come back to the desired route parallel to the straight route sections at the desired distance from point F which represents the end point of the circular segment, a further, relatively narrow circular segment having a small radius is necessary. A straight route element to point H again follows the final point G of this circular segment.

Fig. 2 shows the detailed view of a route. The continuous line shows the route which is desired and which can be realized by the method according to the invention. So as to make clear the difference between the method according to the invention and the conventional method, a lattice as used in the conventional method was laid above the shown portion of the route, and a dotted line shows the route which would be possible by the conventional method, but deviates from the desired route.

In this detailed view, the route which is desired and can be realized by the method according to the invention consists of two straight route elements which are connected by two 90°-circular segments which are arranged in an S-shaped manner. This means that the route runs from point I

straightly to point J, then, across a 90°-circular segment to the right to point K, and from this point K to the left to point L across a 90°-circular segment, from which it is to be driven, parallel to the first straight route section, further to point M. It is obvious that by the method according to the invention, the route can be planned independent of any lattices such that it corresponds exactly to the desired route.

If, however, a lattice is used, the points J, K, and L, which are to be driven to, are located on lattice lines, but not on lattice cross points. Therefore, these points cannot be driven to by conventional methods. Instead, the route would have to be planned in a shifted manner, as shown by the dotted line, and runs across the points J´, K´, L´. Only at point L´, this route runs on the actually desired route again. By the system according to the invention, however, points arranged in an arbitrary manner can be driven to, even points which are not located on a lattice line, such as point N, by simply connecting suitable route elements.

Figure 3 shows a parceled test field 2 for testing different seeds. The parcels 3 are identical, and a corresponding sowing of different seeds can be realized not only by the conventional method but also by the method according to the invention.

Figure 4 shows a test field 4 which is parceled differently for certain reasons which concern its use. There are completely different parcels 5, 6, 7, 8, 9, and apart from square parcels, there can also be hammer-shaped parcels 6. Further, there can be adjoining parcels 8, 9 which have the same size, but which are arranged in a staggered manner. So

as to sow seeds correspondingly in such a test field, a very fine lattice would have to be used in the conventional methods, whereby the expenditure for planning and also for the control of the machine becomes extremely high. By the method according to the invention, however, this is no problem.

Claims

1. A method of planning the route of a machine and for steering the machine on this route, in which signals are transferred to the machine by means of a computer corresponding to the planned route stored in a storage medium, in order to make it possible to steer the machine on the route, **characterized in that** starting out from a starting point (A), the route consists of a plurality of route elements joined together, of which differently defined route elements for planning the route are provided.

2. A method according to claim 1, **characterized in that** straight route elements and curved elements are provided as defined route elements.

3. A method according to claim 1 or 2, **characterized in that** the route elements show different lengths.

4. A method according to claim 2 or 3, **characterized in that** the curved elements show different radii.

5. A method according to one of claims 2 to 4, **characterized in that** curved elements show changing radii.

6. A method according to one of claims 1 to 5, **characterized in that** route elements are provided which represent standard manoeuvers, such as turns.

7. A method according to one of claims 1 to 6, **characterized in that** the route elements are

direction-oriented and determine the traveling direction.

8. A method according to one of claims 1 to 7, **characterized in that** operational functions of the machine are assigned to the route elements.

9. A method according to claim 8, **characterized in that** soil ground treatment functions of the machine are assigned to the route elements.

10. A method according to one of claims 1 to 9, **characterized in that** machine-specific parameters are assigned to the route elements.

11. A method according to one of claims 1 to 10, **characterized in that** control parameters for controlling the machine, such as traveling speed and maximum angle of turn, are assigned to the route elements.

12. A method according to one of claims 1 to 11, **characterized in that** the computer performs a control of the machine on the basis of the signals.

13. A method according to one of claims 1 to 12, **characterized in that** machine parameters are filed in a machine library.

14. A method according to one of claims 1 to 13, **characterized in that** planned routes are filed in a route library.

15. A method according to claim 14, **characterized in that** routes are connected with operational functions of the machine which concern machine parameters and/or data.

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Fig. 1

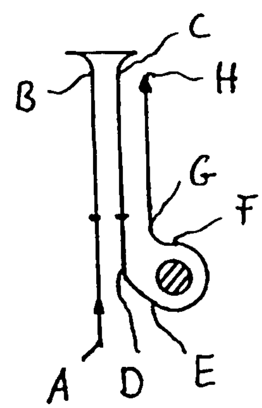

Fig. 2

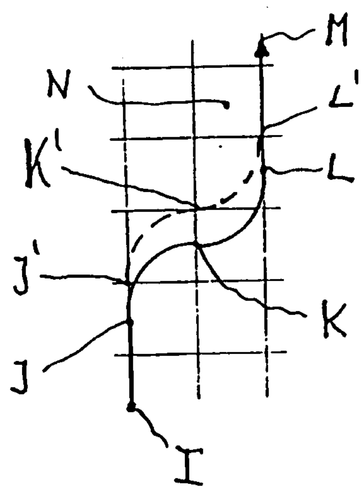

Fig. 3

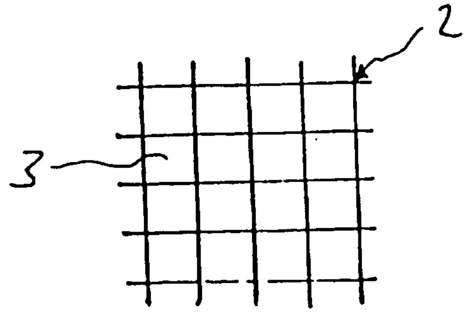

Fig. 4